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Phosphorus and Sulphur Management for Canola Production

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Canada 

Canola is a Heavy User of Phosphorus and Sulphur

- Removal of P is slightly higher than that of wheat on a per bushel basis
- Requirement and removal of S is much higher than that of wheat
- Nutrient management decisions are affected by both plant characteristics and chemical behavior of P and S



Principles of Phosphorus Nutrition that Affect Fertilizer Management Choices



- P is not very mobile
 - Ties up with Ca, Mg, Al and Fe
 - Will not normally leach on most soils
 - Roots must intercept P since P won't move to roots
- P is needed early in growth
 - Plants must have adequate supply in first 3-6 weeks
 - Soil supply is reduced under wet, cold conditions
- Adequate P needs to be near the seed-row so the plants can access it early in the season
 - May need to apply starter near the seed-row unless the soil level is high

How Much Phosphorus is Needed by a Canola Crop?

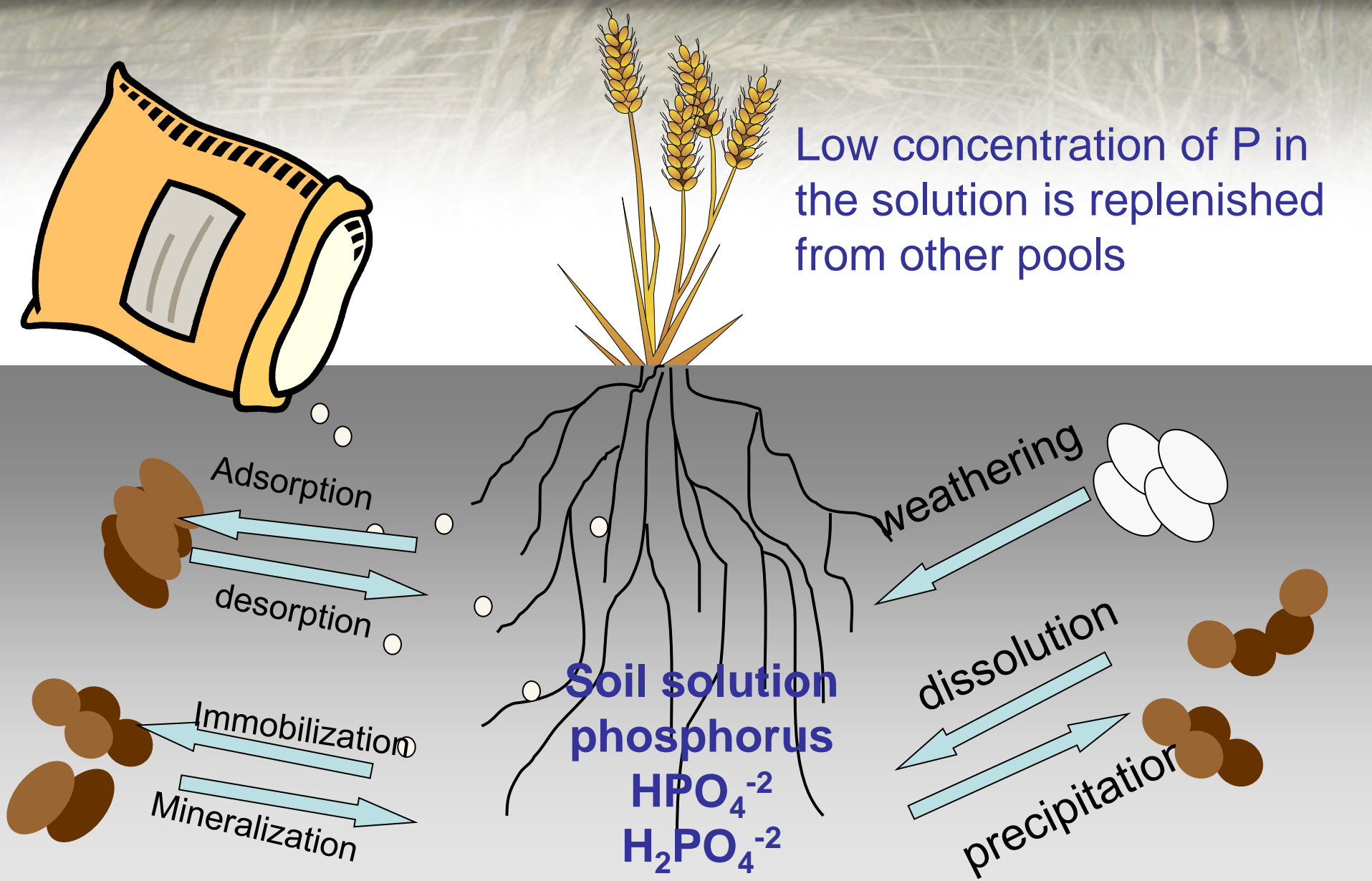
- A 40 bu/acre canola removes about 38 lb P_2O_5 per acre in the seed
 - About 20 lb more taken up but recycled in residue
 - Total of about 58 lb needed for growth



Without an adequate P supply, crop yield will be reduced

But not all crop requirement has to come from fertilizer

Plants Access P from Soil Solution



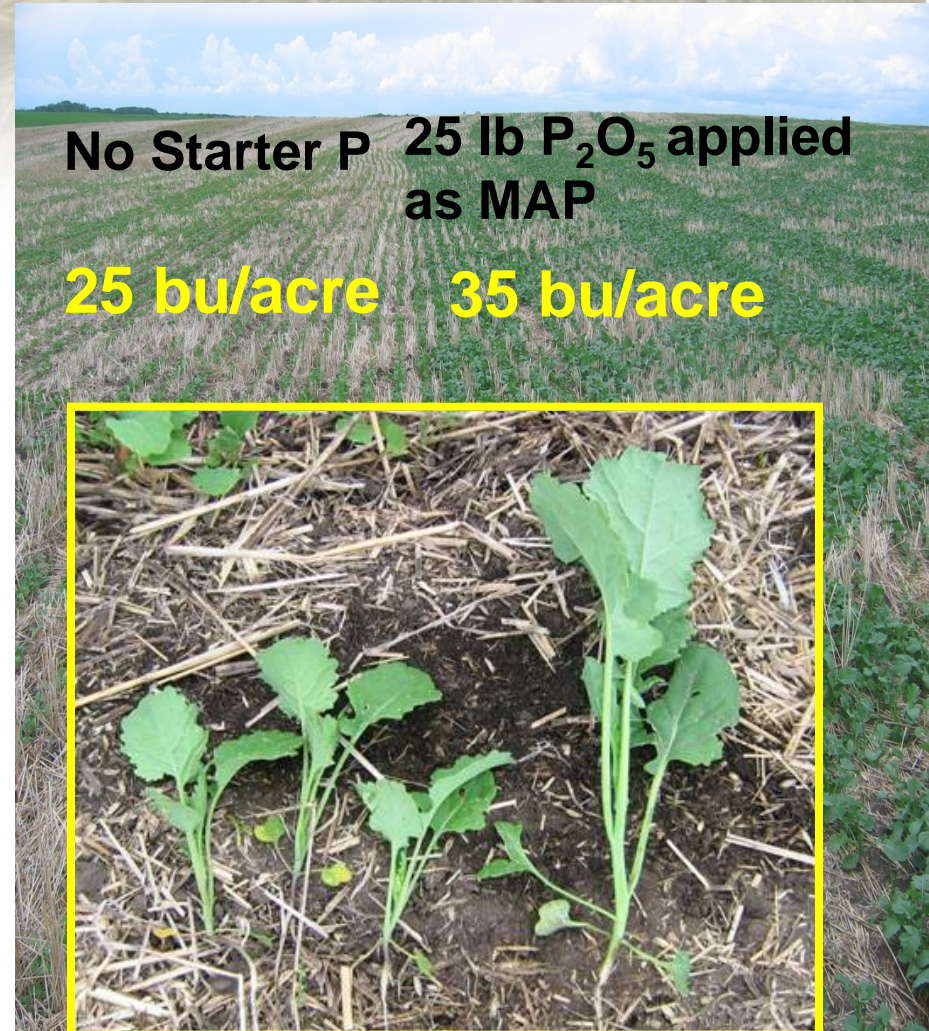
Crops Differ in Ability to Access Soil and Fertilizer P



- Flax has poor ability to take up fertilizer P
 - relies more strongly on soil P
 - poor response to fertilizer P
- Cereals moderate in their ability to use soil and fertilizer P
- Canola effective at feeding from both fertilizer and soil P
 - modification of rhizosphere
 - proliferation of roots in fertilizer reaction zone

Canola

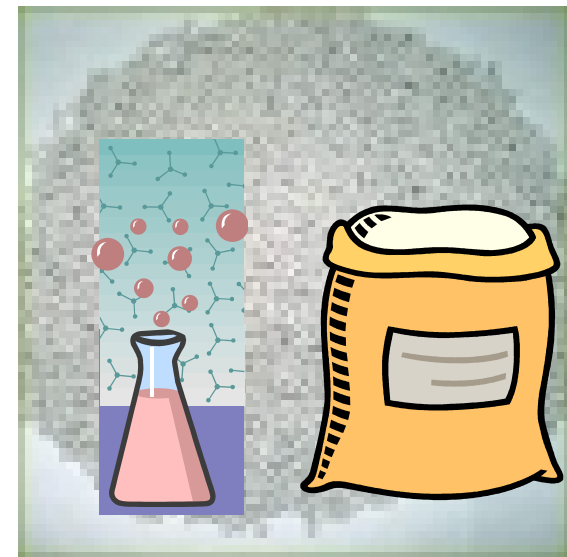
- Canola is highly responsive to P on very low P soils
 - Can use soil P well if soil test P is moderate to high
- Yield will usually be optimized with 15 to 20 lb P_2O_5 ac⁻¹
 - As long as adequate soil P is present for later uptake
- Place as starter near or in the seed-row
- Response to starter more likely on cold soils, with early seeding and low P content



15 lb NW MKP per ac, equiv. to ~ 7 ppm Olsen P

Can Different Fertilizer Formulations Improve P Availability?

- Monoammonium phosphate is the standard fertilizer source for the prairies
 - Ammonium in formulation enhances efficiency
- Ammonium polyphosphate is standard fluid form
- Other novel formulations include:
 - Fluid orthophosphates such as Alpine
 - Avail additive

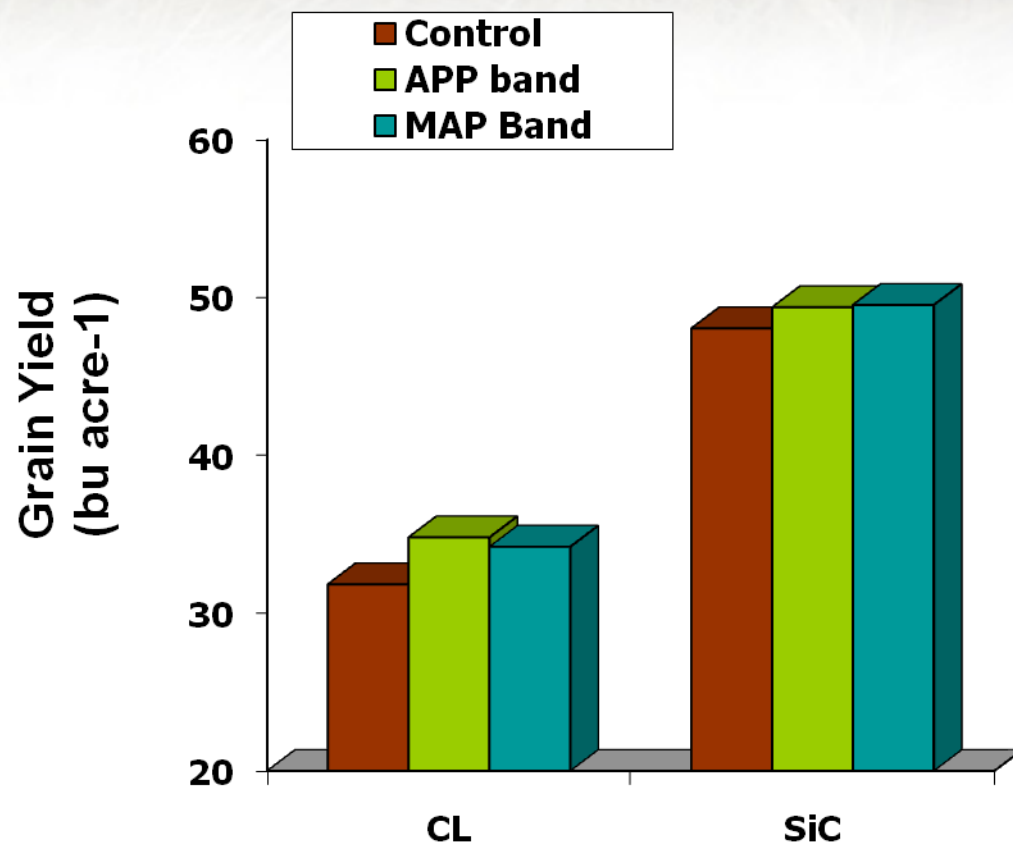


Fluids Versus Dry

- Under arid, highly calcareous conditions in Australia, fluid forms of P are more available than dry
 - Water moving toward granule carries Ca
 - Ca precipitates P and leads to small reaction zone
 - Fluid forms increase reaction zone and allow greater root uptake
- Similar benefit has not shown up in tests in Manitoba and is unlikely in humid areas

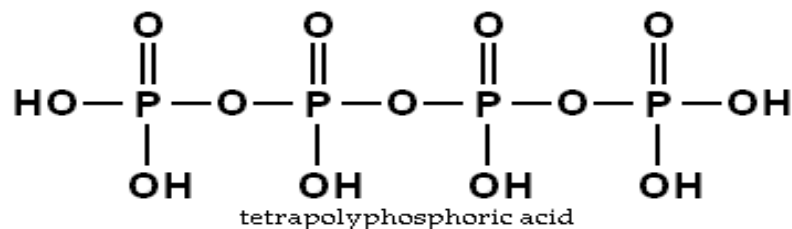
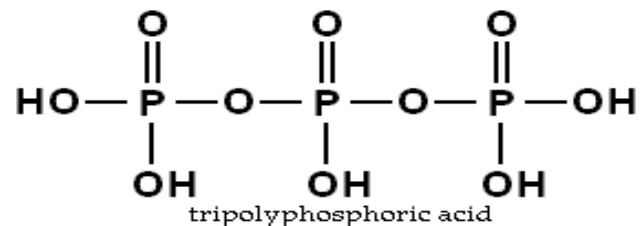
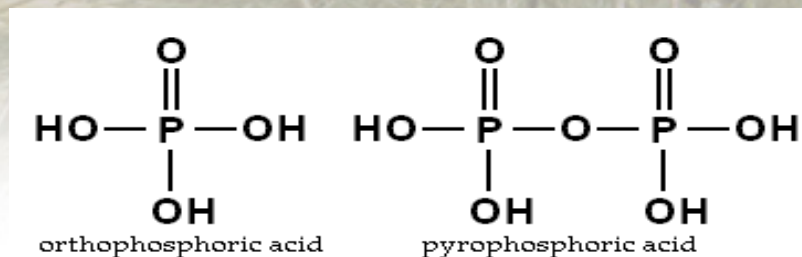
There was no difference between dry MAP and fluid APP in wheat yield over three years at two sites near Brandon

- Similar results in previous studies by Racz and in later studies on wheat and soybean
- Soils are more humid and much less calcareous than the 70% calcium carbonate in the Australian trials



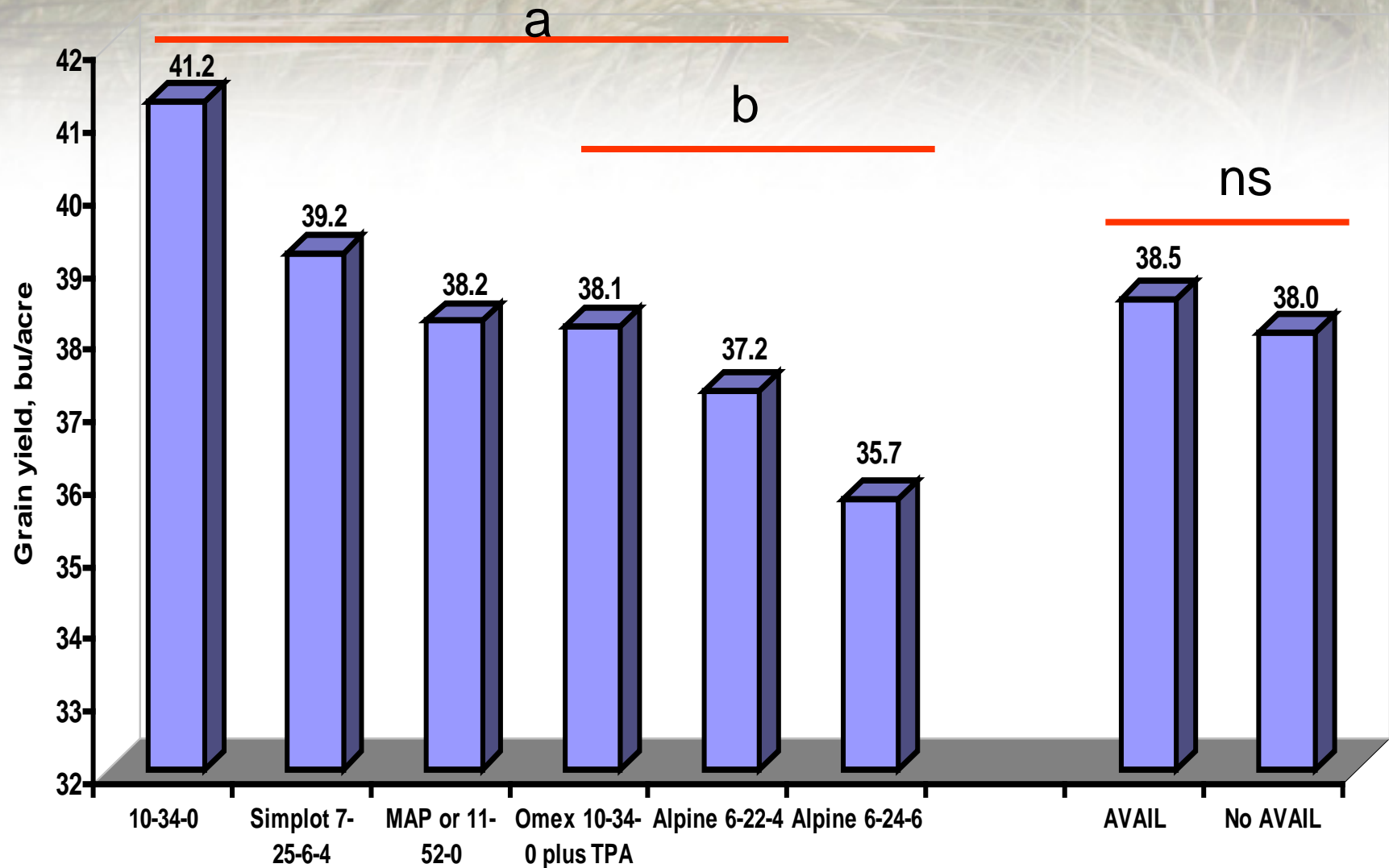
Orthophosphates versus Polyphosphates

- Polyphosphates are chains of orthophosphates
- Most polyphosphate fertilizers still have 40-60% of the phosphate in the orthophosphate form
- Polyphosphate converts to orthophosphate in soils rapidly
 - Half usually is converted within a week,
 - Conversion may be slower if soils are cool and dry
- Generally no difference in effectiveness under field conditions

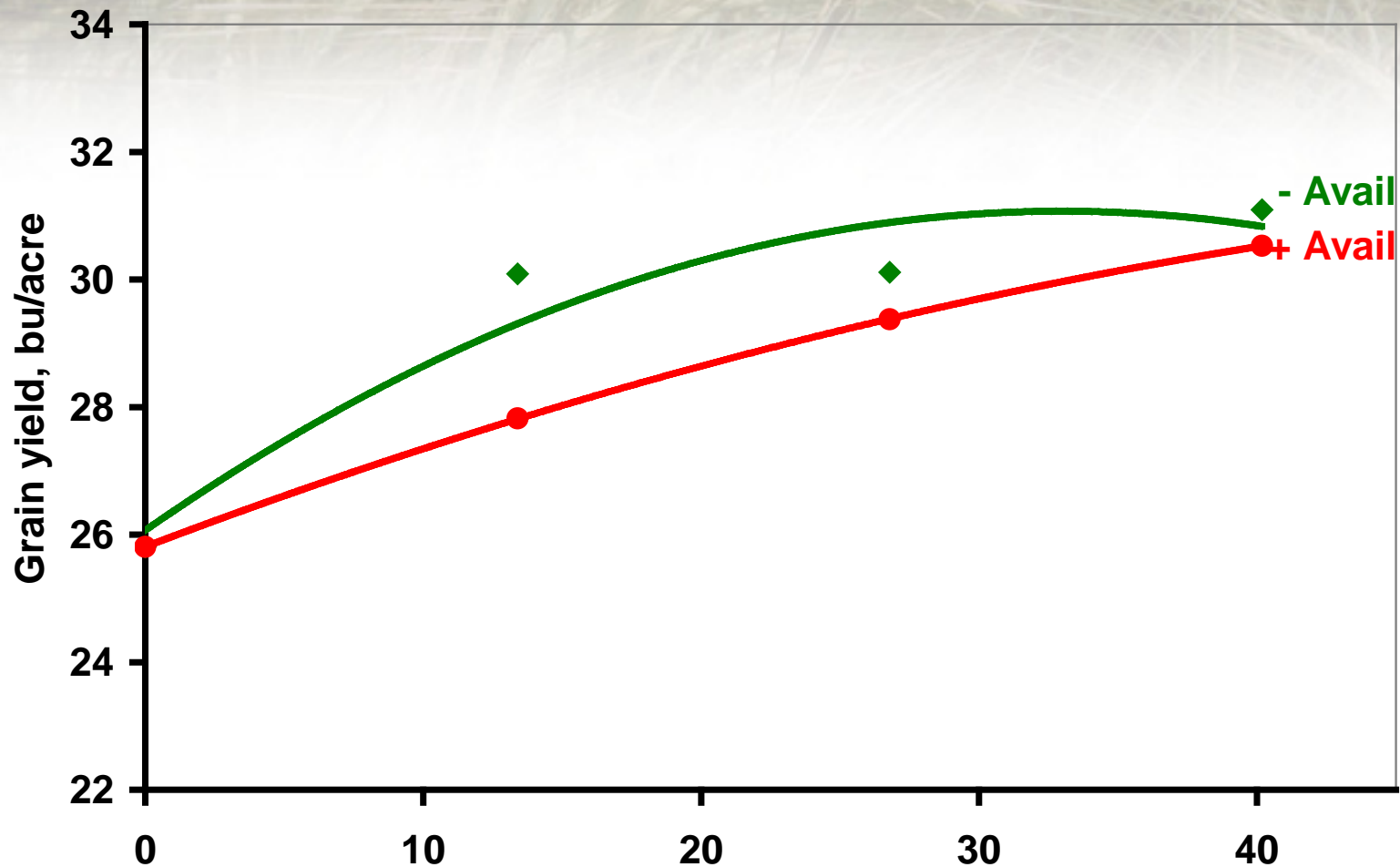


- <http://www.extension.umn.edu/distribution/cropsystems/D C6288.html>

In studies by Tom Jensen at Brandon, 10-34-0 and MAP performed as well or better than enhanced P products (Average of 8, 16 and 32 kg P ha⁻¹)



In wheat on the prairies, yield was similar if MAP was applied with or without Avail

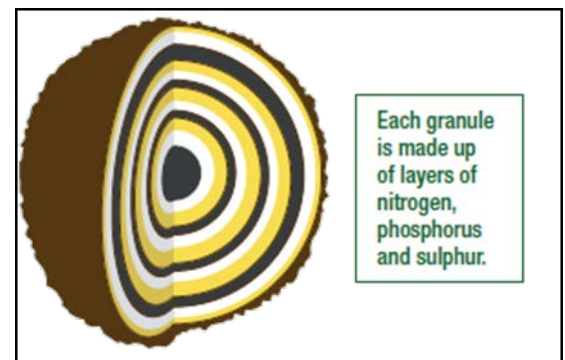


Wheat (6 site-years) Phosphorus rate, lb P₂O₅/acre

Karamanos

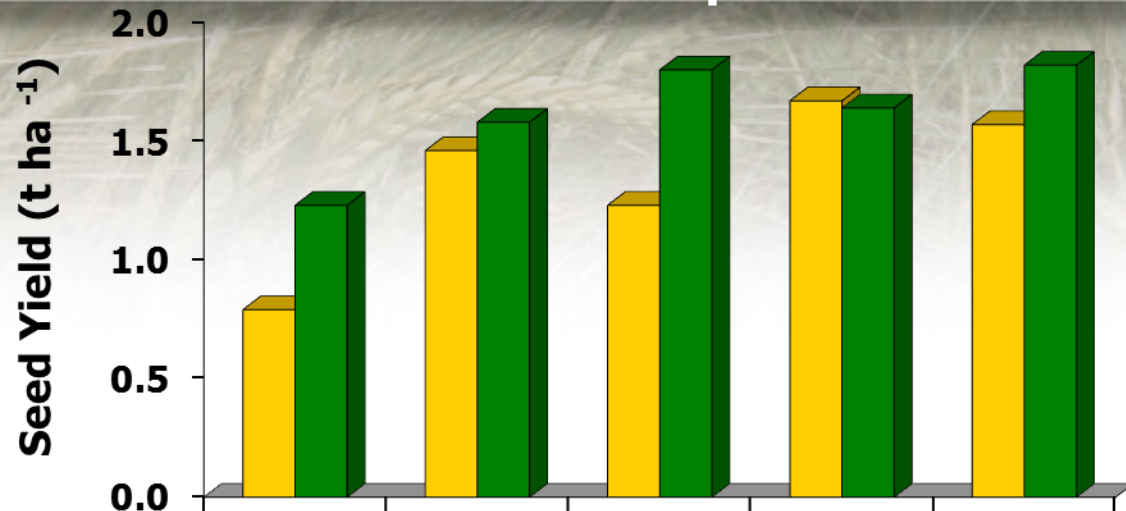
MicroEssentials S-15

- Blend of monoammonium phosphate, ammonium sulphate and elemental sulphur (13-33-0-15)
- “Onion-skin” layers of sulphur
- Mosaic product
- Good product for seed-placement
 - Good distribution and seed safety
 - P availability is as good as MAP

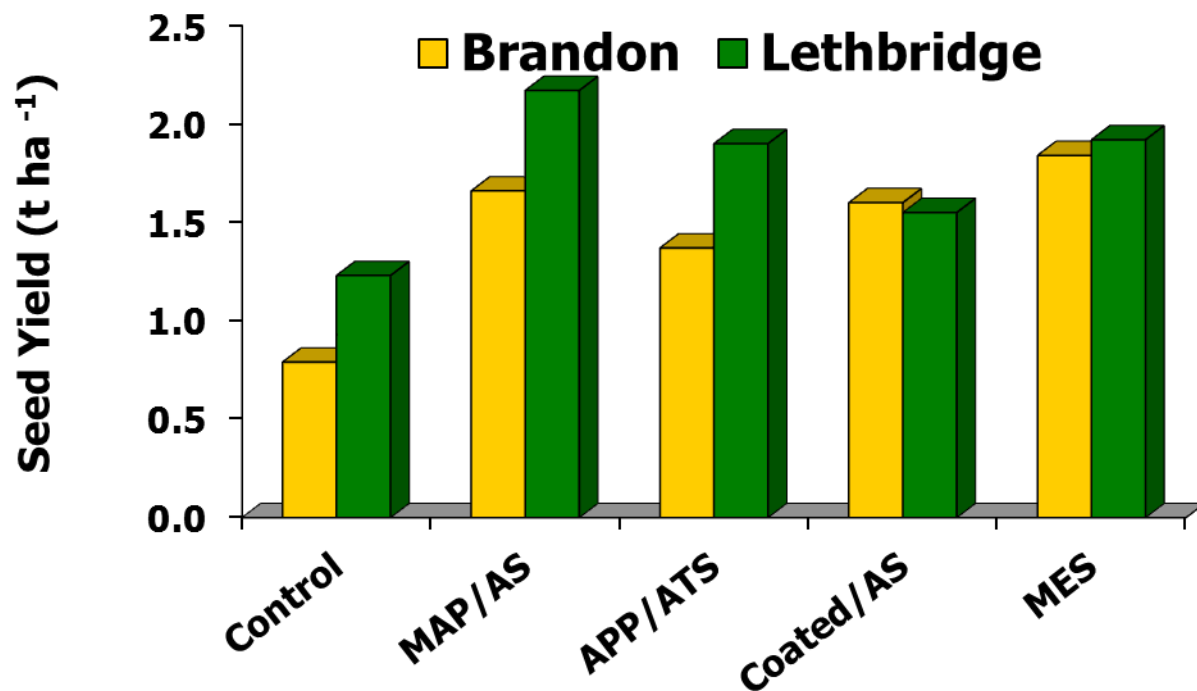


Canola Seed Yield was Similar with Use of MES and other S and P Sources at Two Responsive Sites

20
Phosphate
and 9 S

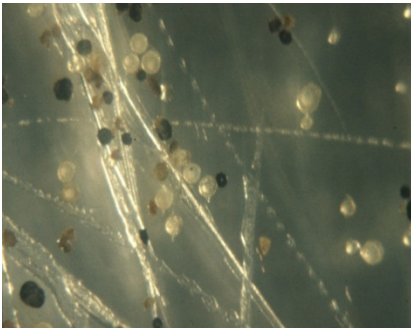


40
Phosphate
and 18 S

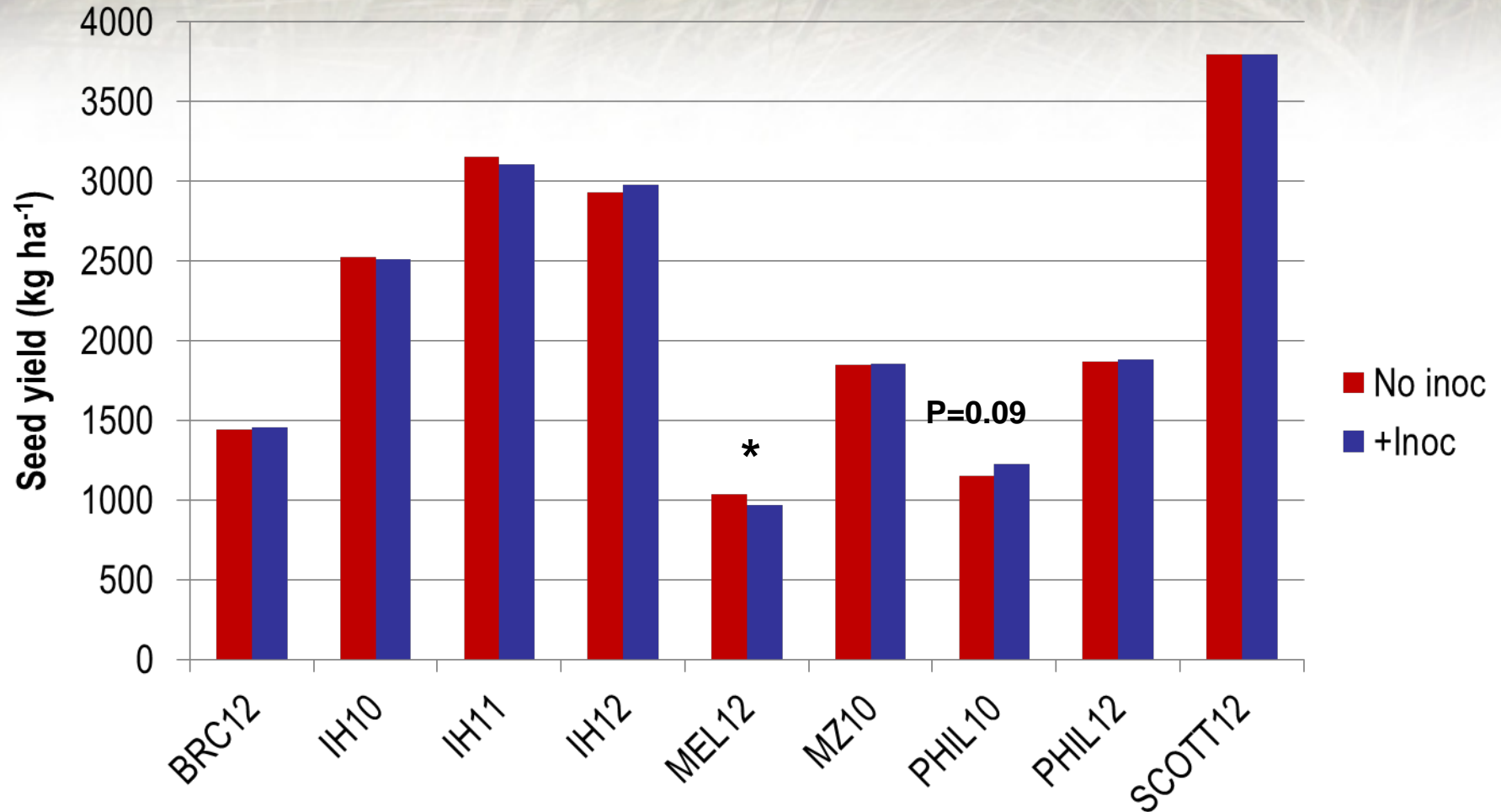


What about the microbial products?

- Two major products sold in western Canada
- Mycorrhizal inoculants – not for use with canola since canola does not form mycorrhizal associations
- Provide (Jumpstart and part of Tagteam -)
 - *Penicillium bilaii* (also classified as *P. bilaji* and *P. bilaiae*) is a fungus that colonizes the rhizosphere
 - Effective in solubilizing phosphorus (P) under controlled conditions
 - Under field conditions, results have been inconsistent

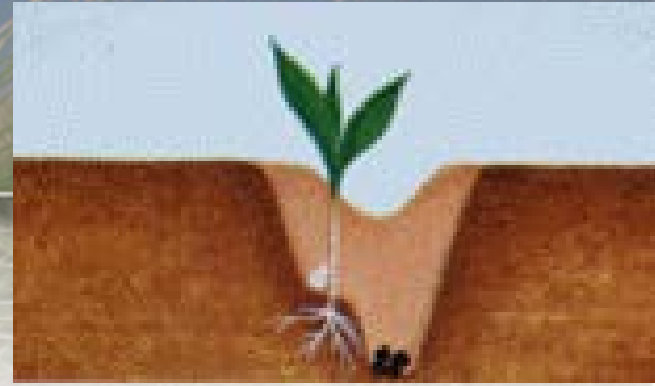


Provide did not benefit canola yield in studies in Manitoba and Saskatchewan



Ramona Mohr

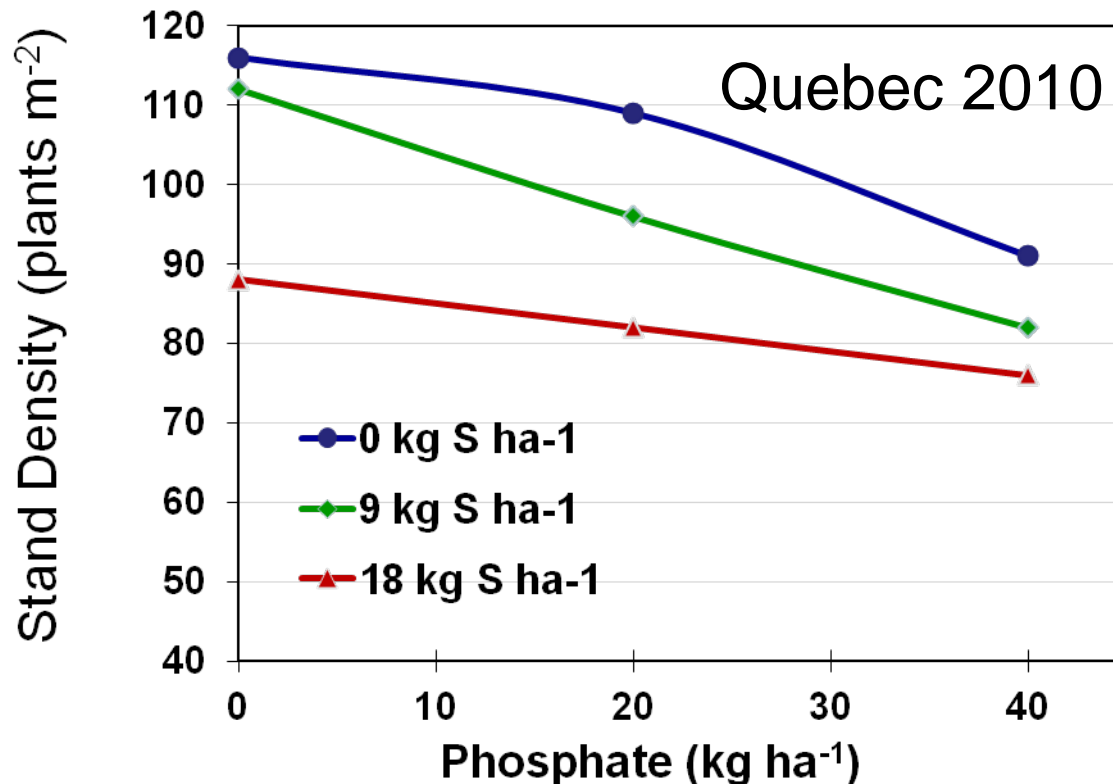
Banding Is the Main Way of Improving P Availability



- Slows tie-up of P in soil
 - Having some N in the band is beneficial
- Bands must be placed where roots will contact them early in season
 - Seed-placed
 - Side-banded
- Canola roots proliferate in bands
 - Fertilizer bands provide high concentration
 - More roots in the band increase uptake
- Especially important with low soil P, cool soils and early seeding

Seed-Placed MAP or APP May Cause Seedling Damage

- Most damage occurred with highest rates of MAP and ammonium sulphate
 - Additive effect of two fertilizer salts





Relying on only the “safe” rate of seed-placed MAP can lead to depletion in canola and soybean crops

| Crop | Yield | P Removal | Seed Limit | Difference |
|----------|---------|-----------|---|------------|
| | bu/acre | ----- | lb P ₂ O ₅ ha ⁻¹ ----- | |
| Wheat | 40 | 29 | 50 | +21 |
| Canola | 40 | 40 | 20 | -20 |
| Soybeans | 40 | 32 | 10 | -22 |
| Barley | 80 | 38 | 50 | +12 |
| Flax | 32 | 20 | 20 | 0 |
| Peas | 50 | 38 | 20 | - 18 |
| Oats | 100 | 29 | 50 | +21 |

*Rates are based on disk or knife openers with a 1 in. spread, 6 to 7 in. row spacing and good to excellent soil moisture

Need to Maintain Soil P at Reasonable Levels

- Excesses can cause environmental problems
- Deficits can reduce potential crop yield
 - Especially if seed-placed P is reduced in sensitive crops
- Target Olsen P levels of around 15 ppm
 - Build levels in cereal years, with large broadcast applications, or with manure
- Consider replacement strategy when target soil levels are attained

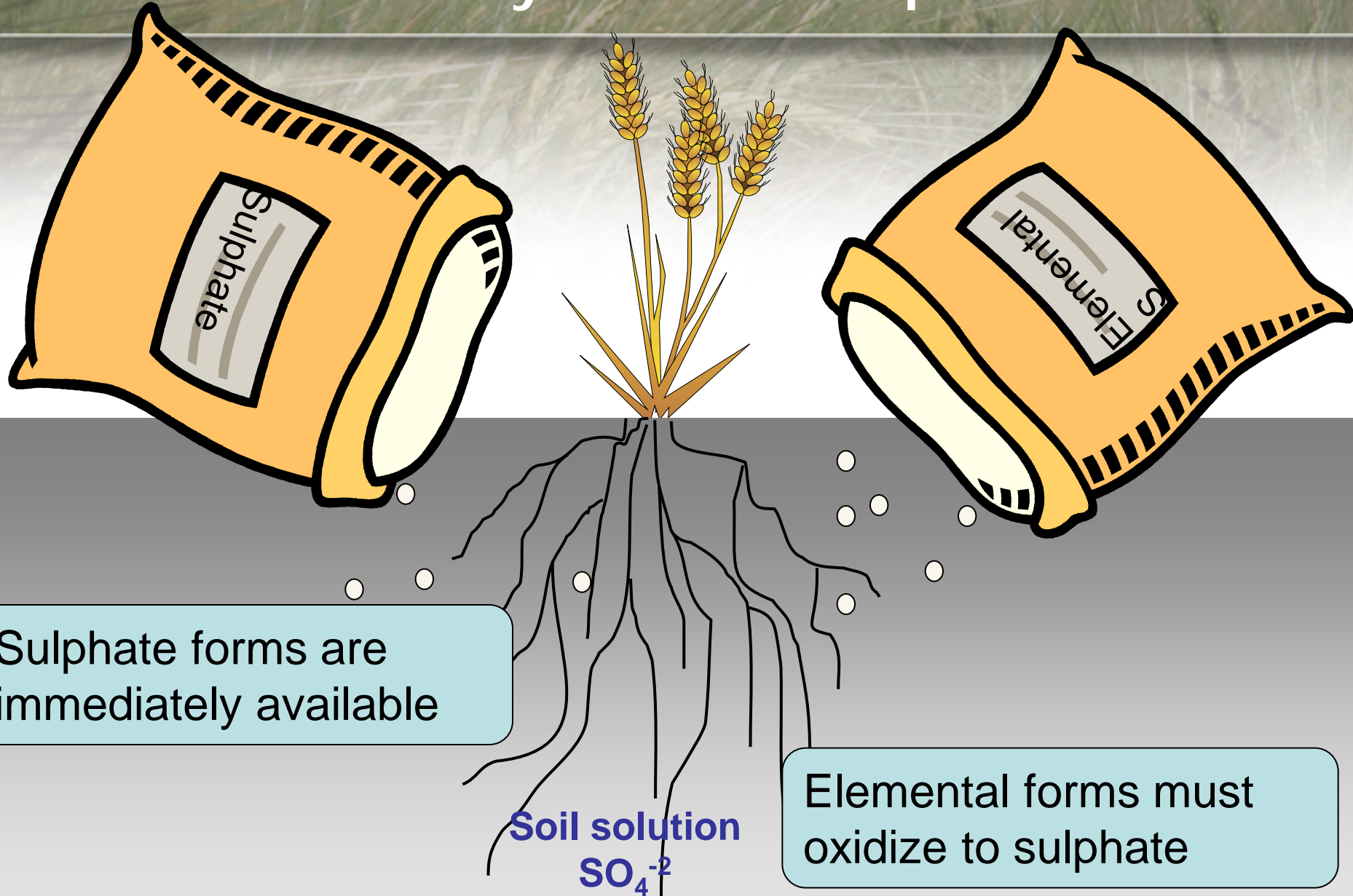


Sulphur Deficiencies are More Common in Canola than in the Other Annual Crops We Grow.

- A 40 bu/acre canola removes about 13 lb S per acre in the seed
 - About 10 lb more taken up but recycled in residue
 - Total of about 24 lb needed for growth
- Compares to about 4 lb removed in a 40 bu/ac wheat crop or 7 lb/ac in a 50 bu/ac pea crop



Plants Only Absorb Sulphate-S



A Range of Sulphur Sources Are Available

Sulphate Sources

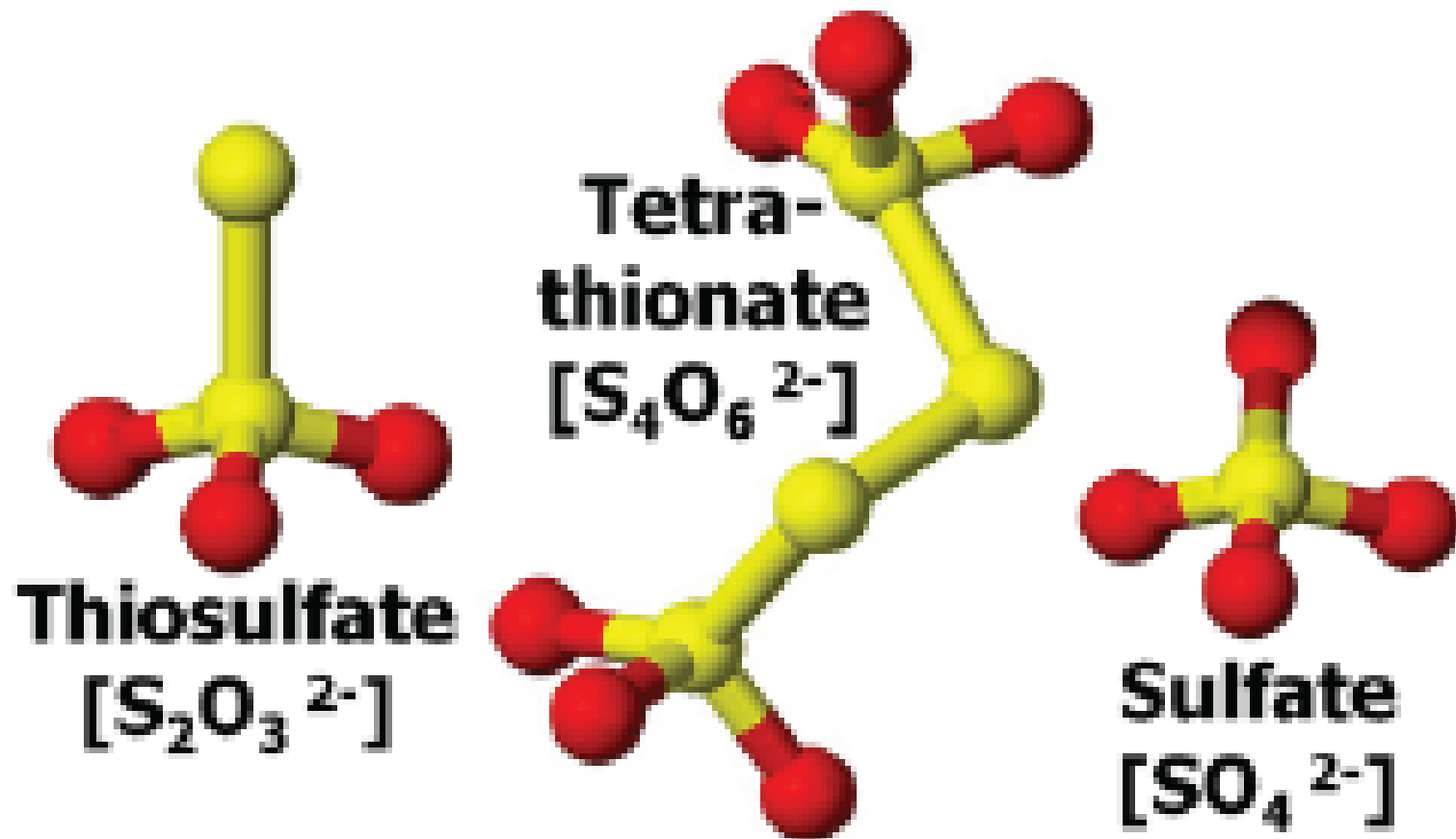
- Ammonium sulphate
- Ammonium thiosulphate
- Gypsum
- Microessentials S-15

Elemental Sources

- Elemental S
- Bentonite blends
- Vitasul
- Microessentials S-15

Manage sulphate and elemental sources differently

Ammonium Thiosulphate Converts Rapidly to Sulphate

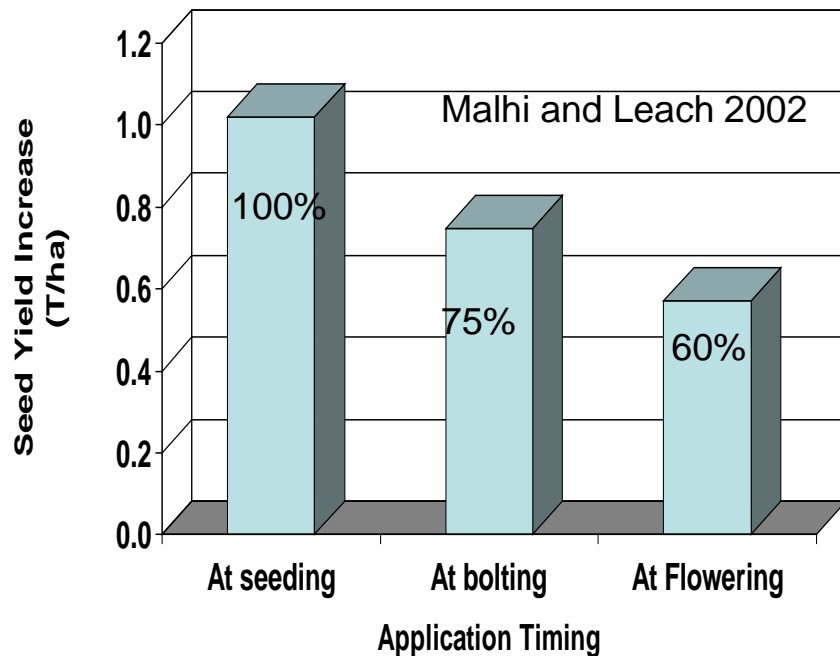


Sulphate Sources Are Immediately Available so Timing of Application is Flexible

- Ahead of seeding
 - S portion will not volatilize
 - May possibly immobilize or leach but to lesser extent than nitrate
- Near seeding
 - Readily available
 - Reduces risk of leaching below rooting zone
- Post-seeding
 - Can be effective, even when delayed
 - Option where deficiencies are noticed late



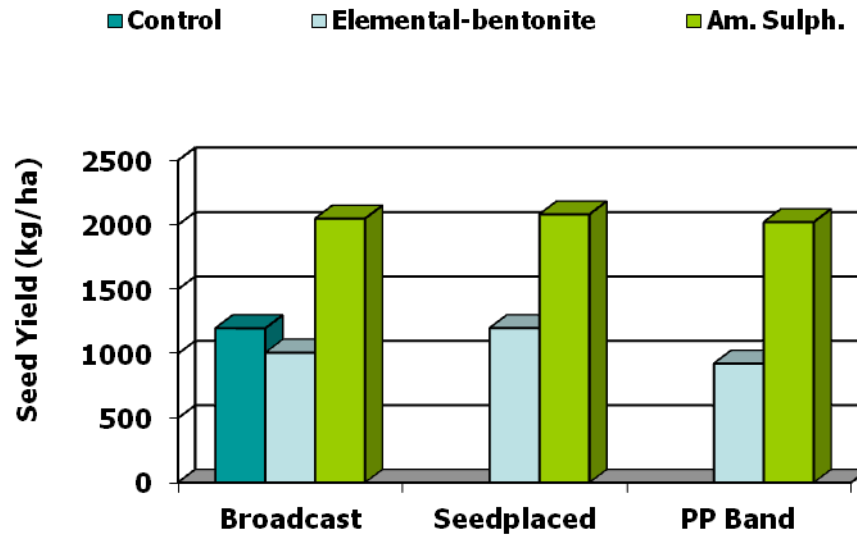
Managing Post-Emergence Sulphur



- Response is still greatest when S is supplied early
 - Watch for deficiencies early
 - spraying time.
- Act quickly when you see a problem and use sulphate sulphur.
- Understand the deficiencies may “disappear” with crop rooting into gypsum, salts or leached S

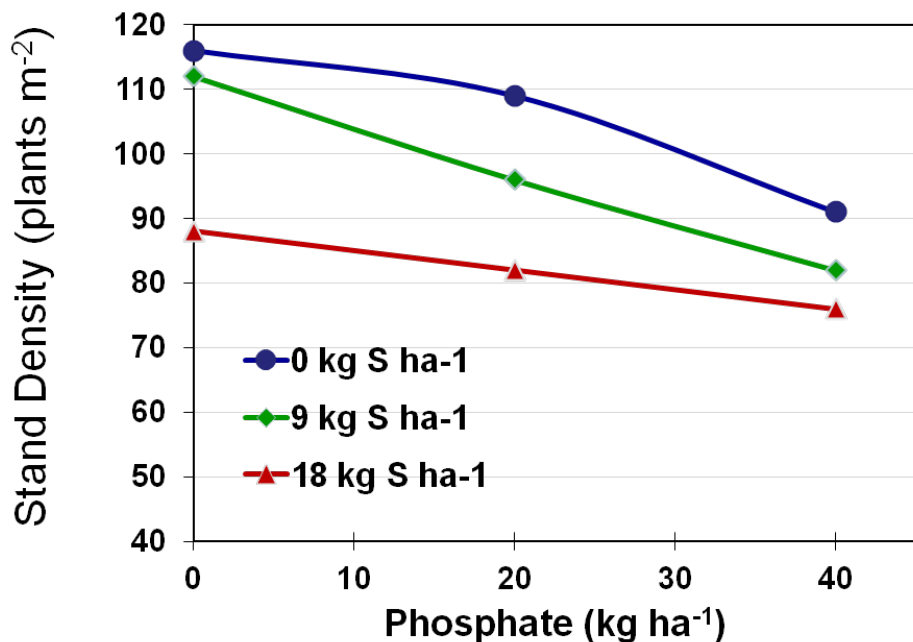
Sulphate Sources Are Mobile in the Soil so Placement Options Are Flexible

- Banding – pre-plant, mid-row or side-banding
- Broadcast
- Dribble-band
- Seed-placement
 - Avoid excesses that could cause toxicity



Excess Seed-placed Ammonium Sulphate can Cause Seedling Damage in Canola

- Stand density decreased with increasing rates of ammonium sulphate
- Most damage occurred with highest rates of MAP and AS



Greater risk on calcareous soils

Soil from a Hilltop



Soil from a Hollow



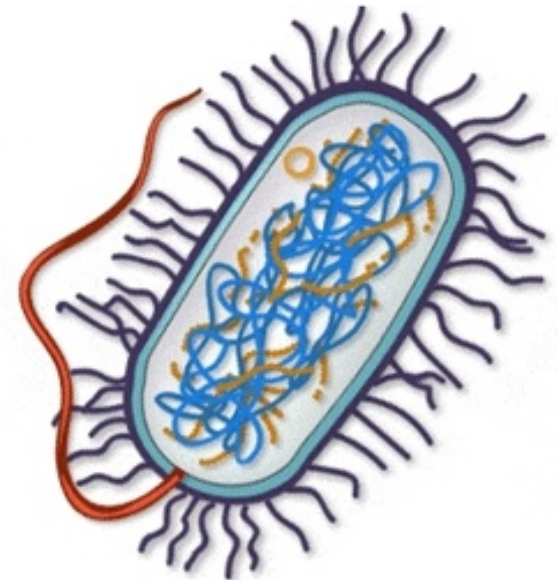
0 9 18 kg

Figure 2: Effect of AS on canola seedling emergence in soils from Brandon

Grenkow

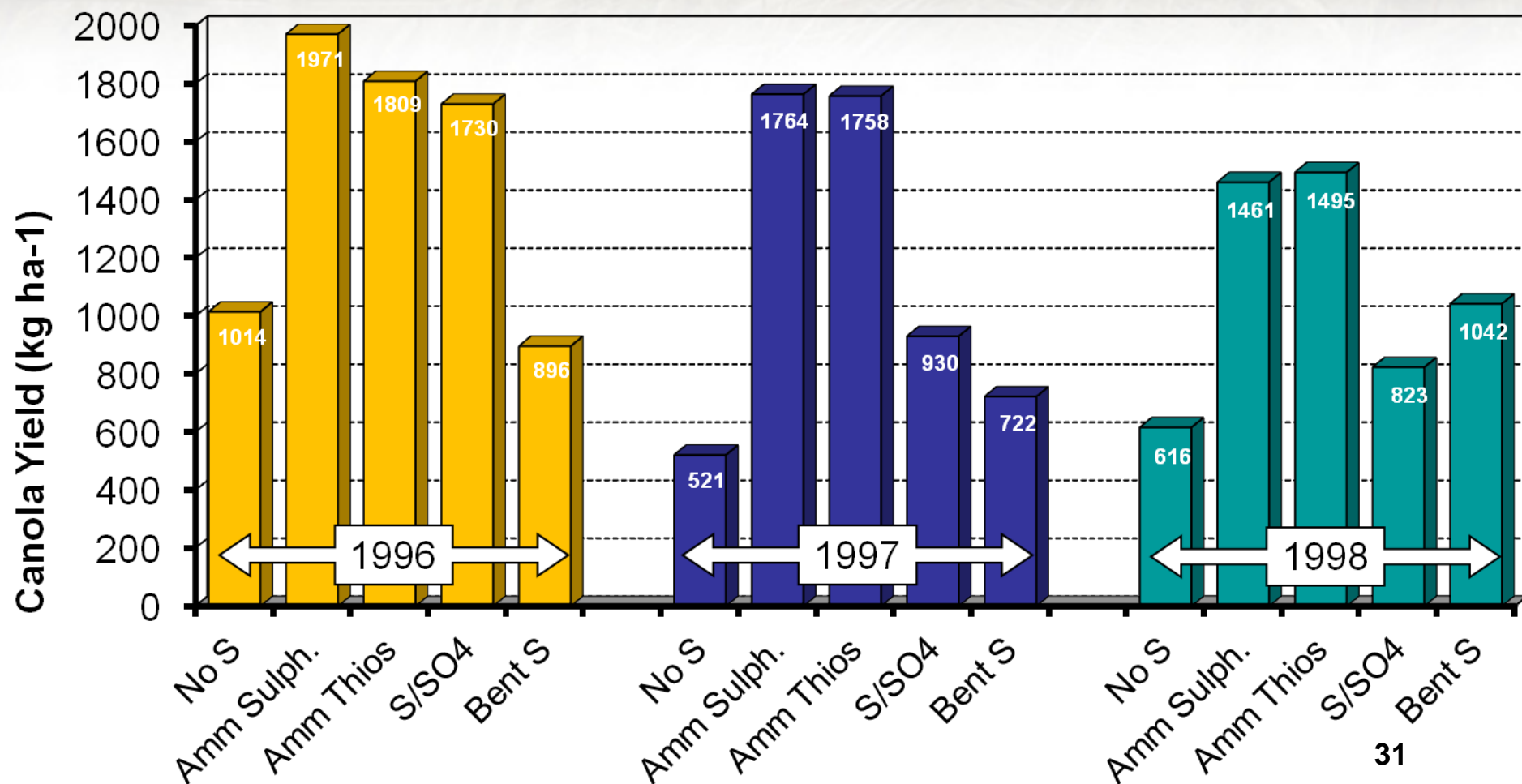
Elemental Sources Must Oxidize to Sulphate

- Requires time and conditions for microbial activity
 - Slower under very wet, dry or cool conditions
 - Often too slow under Prairie conditions
- Apply far before crop requirement
- Use finely divided product
- Broadcast rather than band
 - Want to maximize contact with microbes
- Leave on surface to “weather”
- Incorporate after weathering

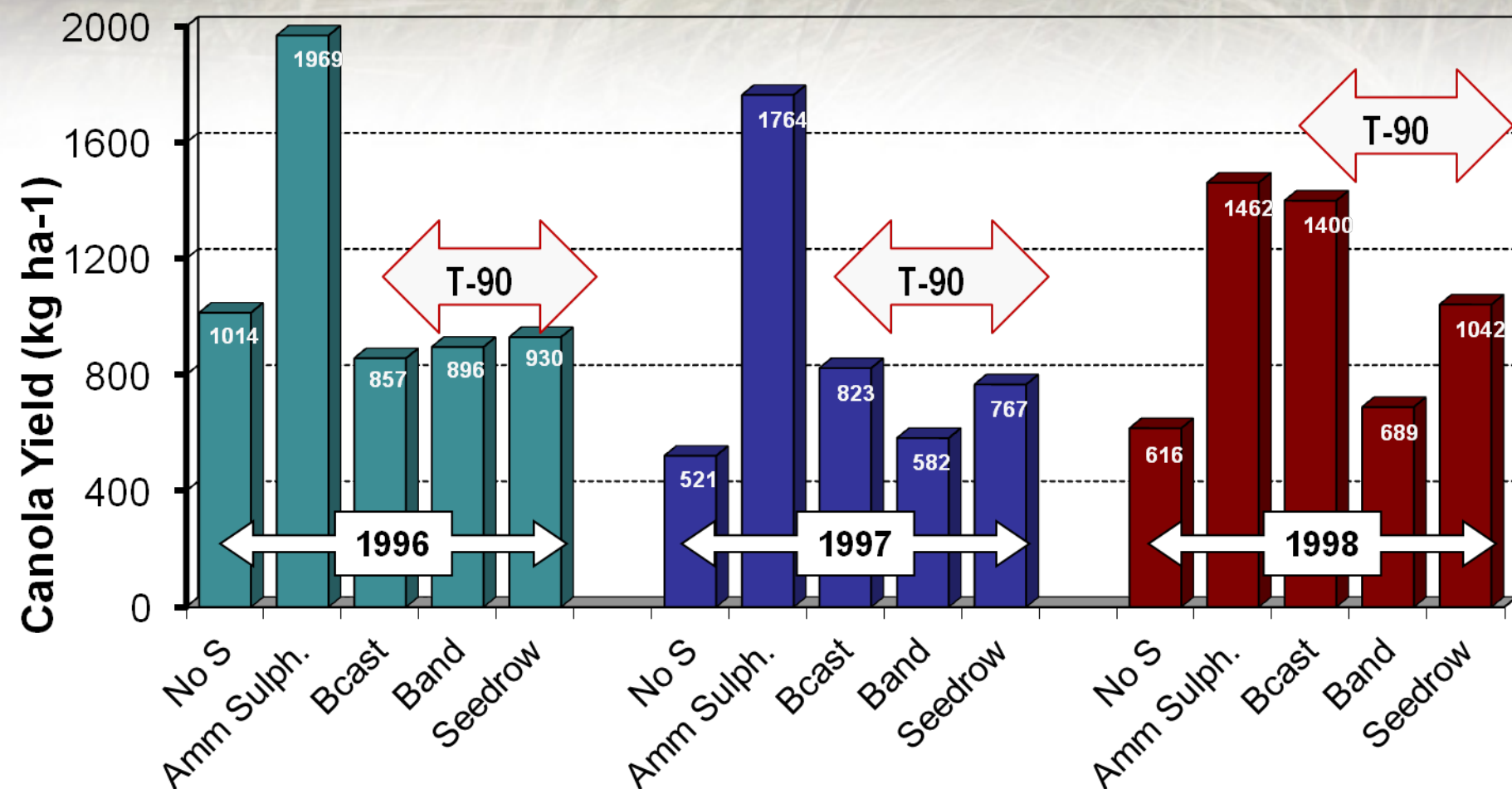


Sulphur Source Study at Melfort from 1996 to 1998

One application of 20 kg S ha⁻¹ in 1996

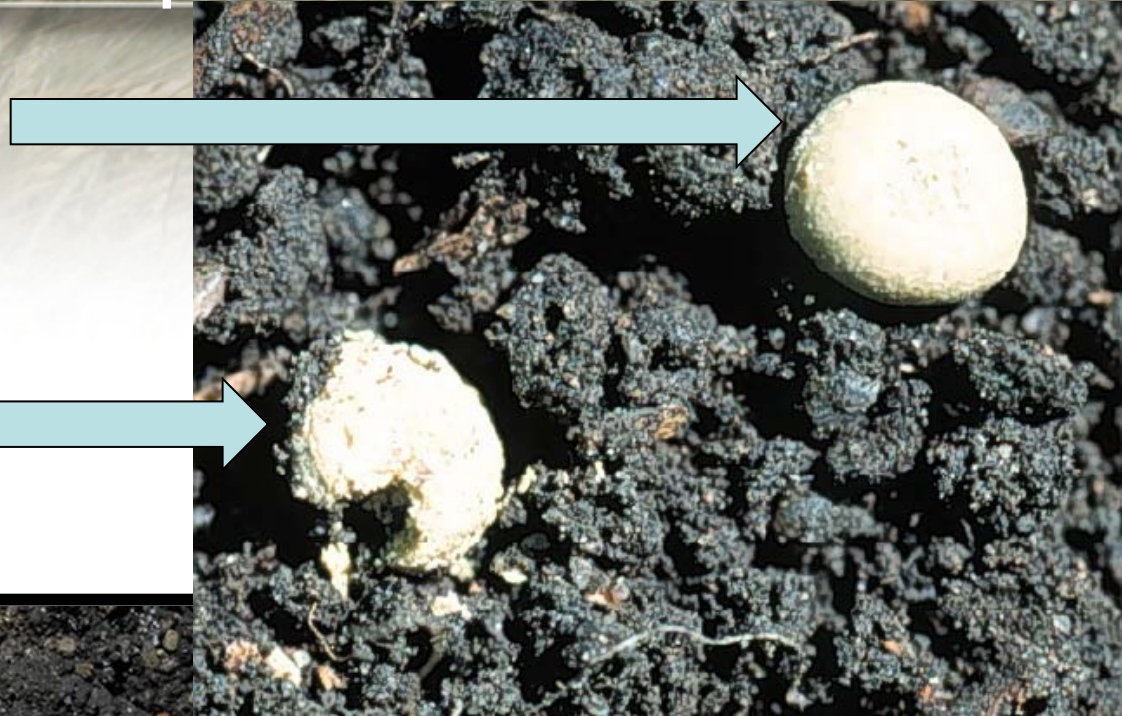


In-Soil Banding Delays the Availability of Elemental S



Weathering on the soil surface speeds breakdown, while band-placement restricts it

Freshly applied T-90 pellet



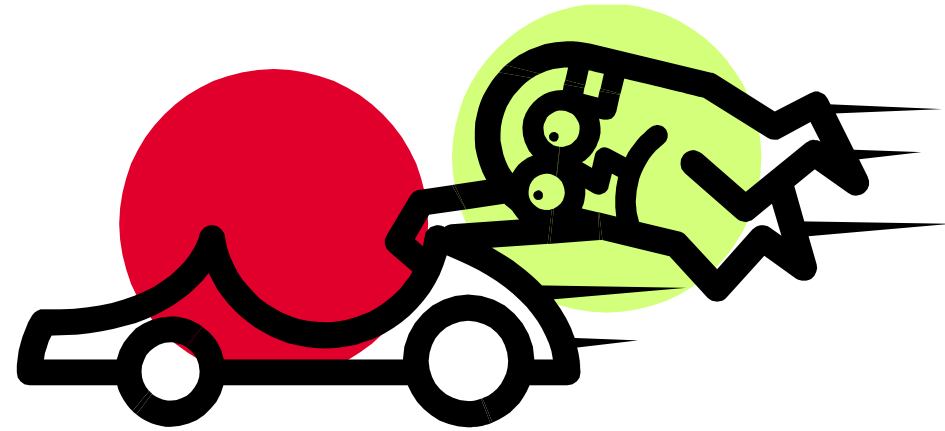
T-90 pellet after 90 days
in seed-row



Pellet after
weathering on soil
surface

New Products Aim to Hasten Conversion of Elemental S

- MicroEssentials S15
 - Onionskin
- Vitasul
 - Greater dispersion
 - Smaller particles

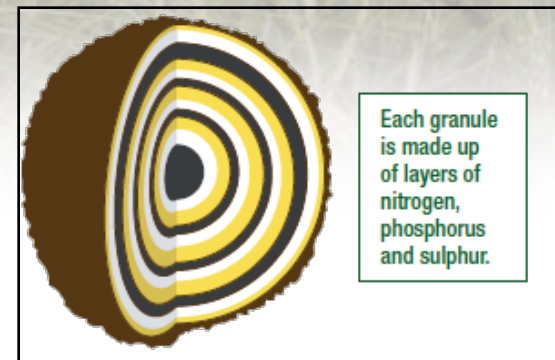


Greater dispersion and contact with microorganisms should hasten oxidation

MicroEssentials S15 by Mosaic

13 – 33 – 0 – 15

- Ammonium Phosphate
- Ammonium Sulphate
- Elemental S



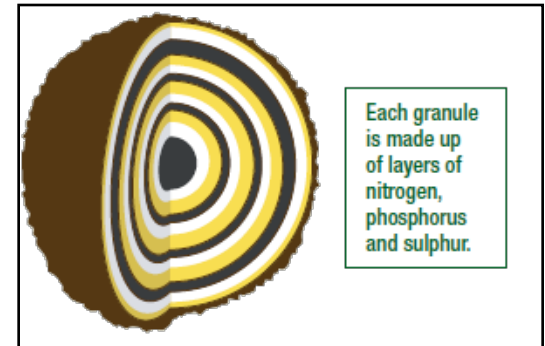
- **½ S in sulphate form (plant available)**
- **½ S in elemental form (requires conversion)**



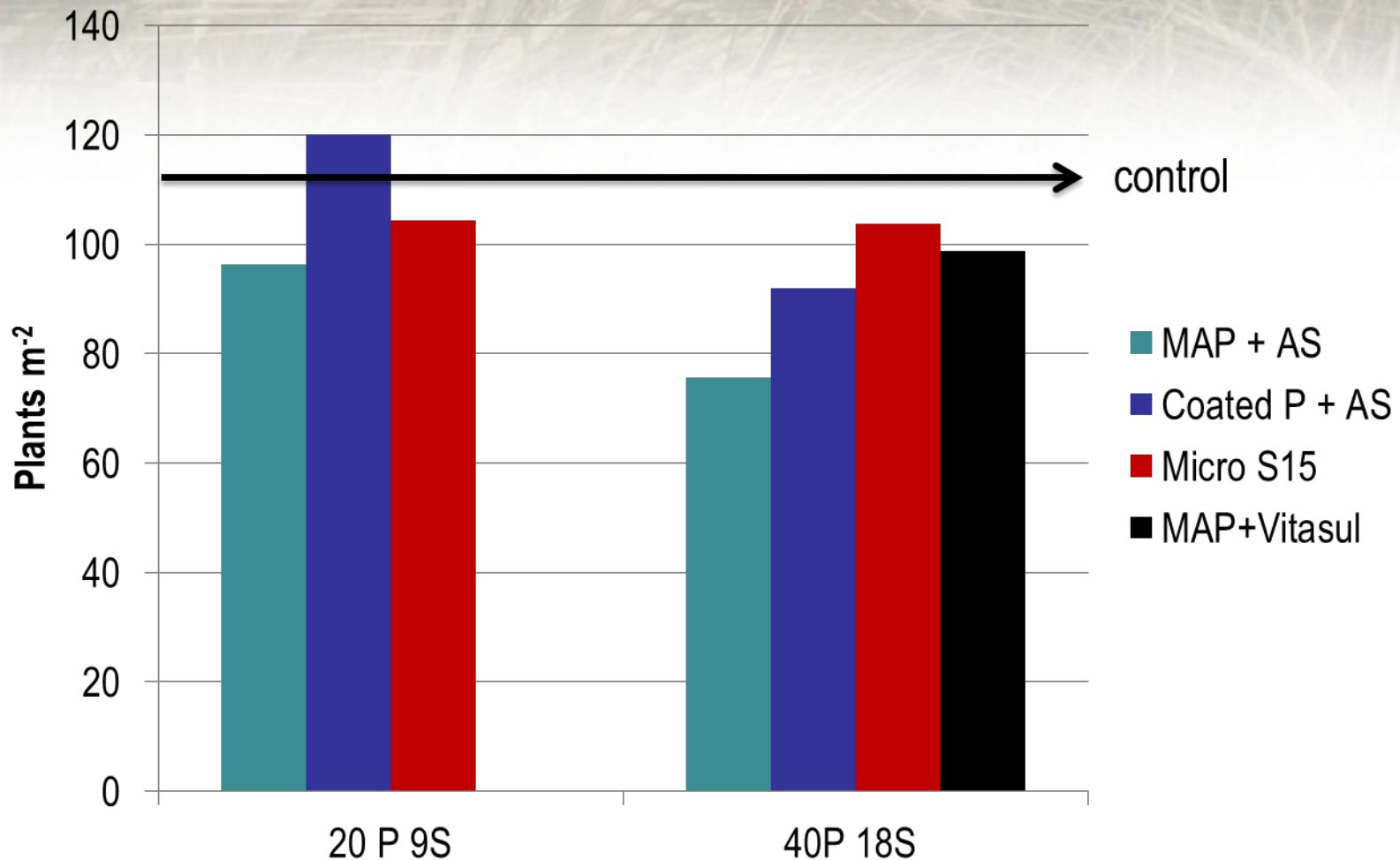
Advantages of MicroEssentials S15

- Lower salt index than a blend of MAP and AS
 - Improved seed safety
- Better distribution of P and sulphate in the seed-row
- Co-granulation of AS and MAP may improve P uptake
- Conversion of elemental to sulphate does not appear to be hastened

-Only count on $\frac{1}{2}$ of the S being available since elemental S will not convert rapidly

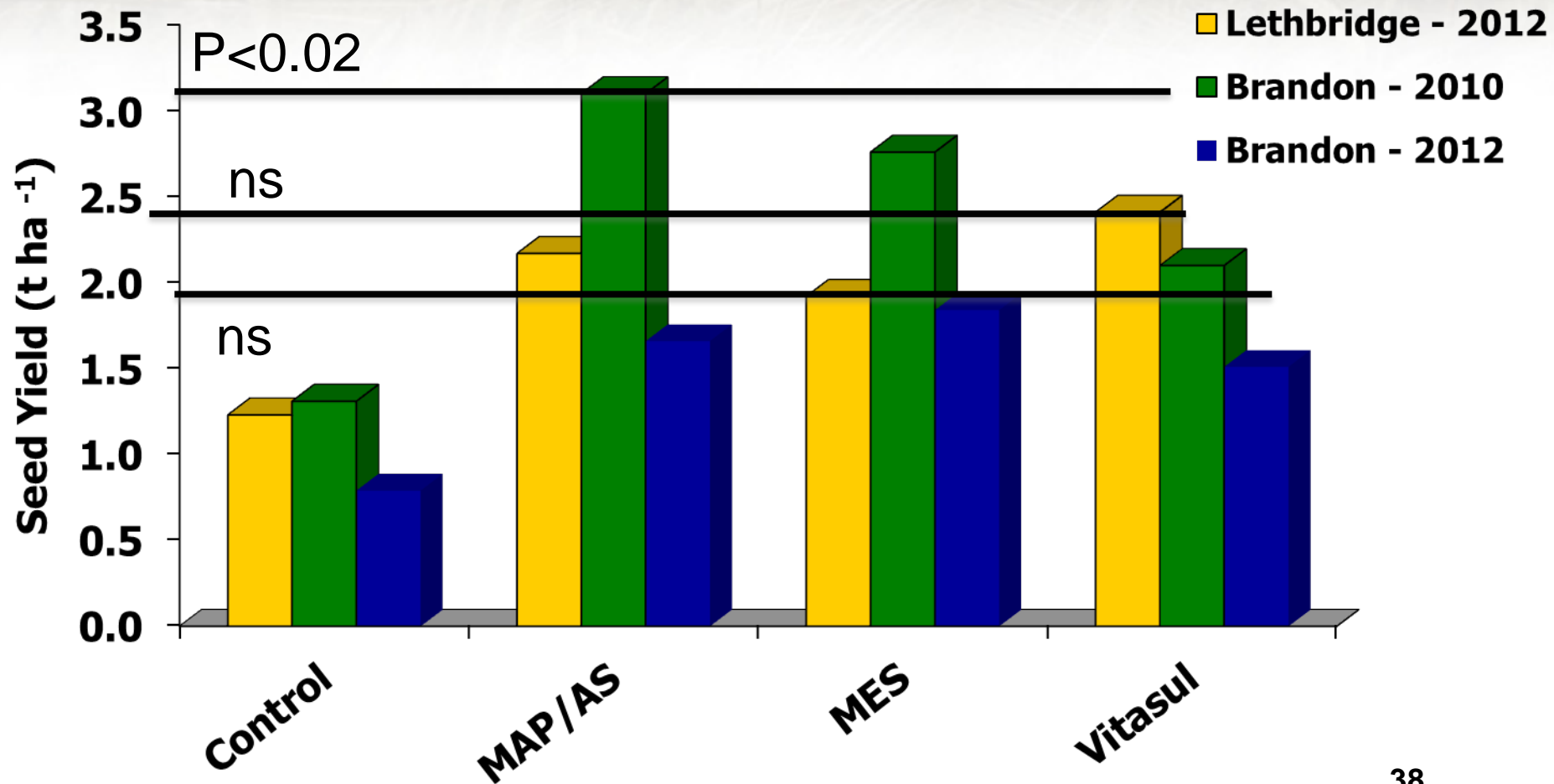


MicroEssentials S15 and Vitasul had lower seedling toxicity than ammonium sulphate



Canola yield was occasionally lower with elemental S than sulphate but modified products may provide some benefit

40 Phosphate and 18 S



Weather Can Affect S Deficiency



Leaching in Wet Years or Field Areas Increases Risk of Deficiency



7/8/1999

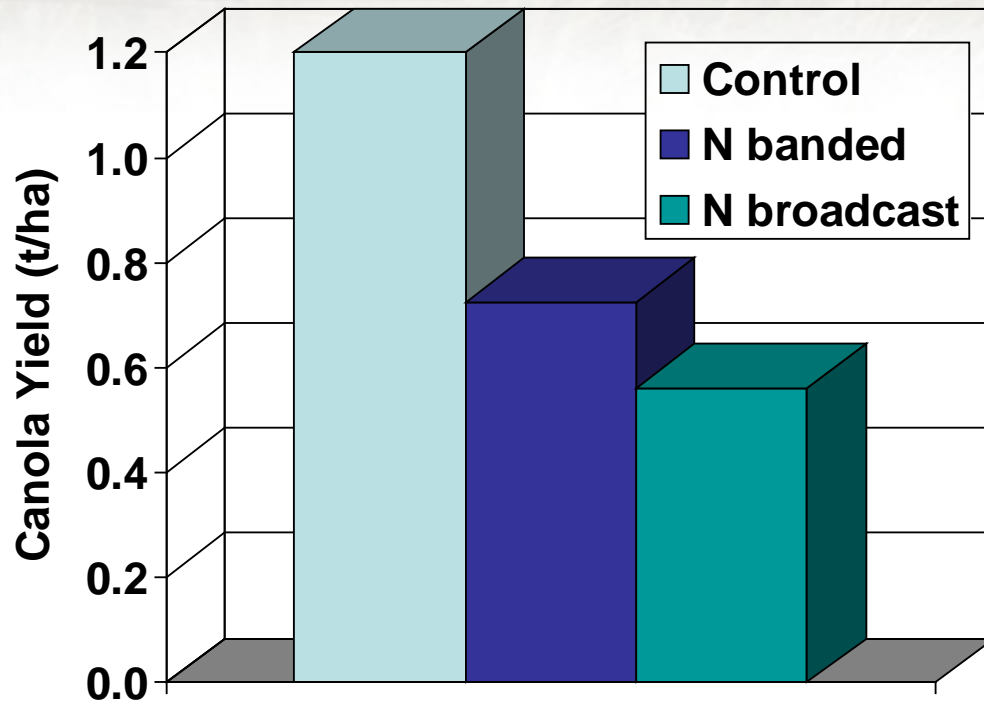
Strong S Response Occurred after a Wet Season

Be particularly alert for S deficiencies after a wet year that promoted leaching

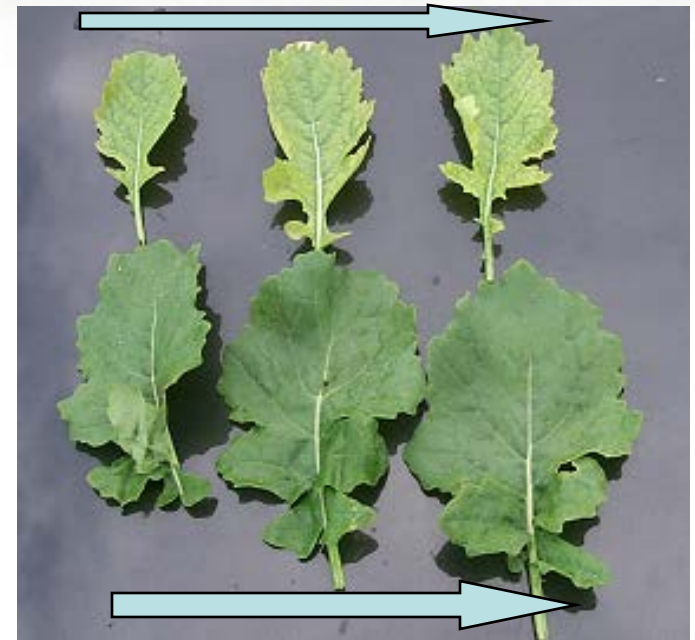
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Adding N without S Can Depress Canola Yield on an S-deficient soil



Increasing N with No S



Increasing N with S

Exact N:S ratio is less important than having an adequate S supply

Summary

- Principles of S fertilization apply
 - Plants take up sulphate
 - Elemental must convert to sulphate
 - Conversion of elemental is slow in Canadian soils
- Conversion of elemental in new products may not be rapid enough to consistently supply S in year of application
 - More research needed
 - May be other benefits in seed safety or distribution
- Very wet conditions can lead to leaching and increase the risk of S deficiencies
 - Keep alert for S problems in wet years



Summary



- Canola will respond well to starter P at low rates
 - Response can occur even with moderate to high soil test P
 - Both the likelihood and the size of P response are greater with low soil test P
- Band placement is generally the most reliable P application method
 - Band in or near seed row where roots intercept early
- Risk of seedling damage from seed-placed MAP or APP
 - With high rates and/or if combined with ammonium sulphate

Summary



- Under standard soil conditions, MAP and ammonium polyphosphate are effective sources
 - Benefits of having some ammonium in product
- No benefits of fluids versus MAP
 - Except on dry, highly calcareous conditions as occur in Australia
- No benefit of orthophosphate versus polyphosphate
- No evidence of consistent benefits from enhanced efficiency products or microbes
- Important to avoid excess accumulation or depletion of P
 - Manage P through the rotation to maintain reasonable soil P

*Thank You to Don Flaten, Larissa Grenkow
John Heard, and Rigas Karamanos for their
input and to you for Your Attention*

